Licorish et al. Research and Practice in Technology Enhanced Learning (2018) 13:9
https://doi.org/10.1186/s41039-018-0078-8

Research and Practice in Technology Enhanced Learning

RESEARCH Open Access

Students' perception of Kahoot!'s influence on teaching and learning

Sherlock A. Licorish[1*], Helen E. Owen[2], Ben Daniel[3] and Jade Li George[1]

* Correspondence: sherlock.licorish@otago.ac.nz
[1]Department of Information Science, University of Otago, PO Box 56, Dunedin 9054, New Zealand
Full list of author information is available at the end of the article

Abstract

Technology is being increasingly integrated into teaching environments in view of enhancing students' engagement and motivation. In particular, game-based student response systems have been found to foster students' engagement, enhance classroom dynamics and improve overall students' learning experience. This article presents outcomes of research that examined students' experience using a game-based student response system, Kahoot!, in an Information Systems Strategy and Governance course at a research-intensive teaching university in New Zealand. We conducted semi-structured interviews with students to learn about the extent to which Kahoot! influence classroom dynamics, motivation and students' learning process. Key findings revealed that Kahoot! enriched the quality of student learning in the classroom, with the highest influence reported on classroom dynamics, engagement, motivation and improved learning experience. Our findings also suggest that the use of educational games in the classroom is likely to minimise distractions, thereby improving the quality of teaching and learning beyond what is provided in conventional classrooms. Other factors that contributed to students' enhanced learning included the creation and integration of appropriate content in Kahoot!, providing students with timely feedback, and game-play (gamification) strategies.

Keywords: Game-based student response systems, Kahoot!, Classroom dynamics, Engagement, Motivation, Learning

Introduction

The rapid increase in the availability and affordability of interactive technologies has contributed to the adoption of games in instructional science and higher education teaching to foster collaborative learning, exploration and discovery (e.g. Ebner and Holzinger 2007; Papastergiou 2009). Students are eager to experiment with different technologies to support their learning, largely because they are skilled in the use of mobile technology and enjoy using applications and games designed for such devices (Prensky 2001). Educational games and game-based student response systems (GSRS; gamification techniques integrated into student response systems) both increase student motivation and engagement (e.g. Barrio et al. 2016; Wang and Lieberoth 2016), especially in circumstances where conventional lecture style or "chalk and talk" teaching are resented by students and induce boredom (Cheong et al. 2013; Graham 2015; Roehl et al. 2013).

Indeed, in New Zealand universities, maintaining students' attention and engagement can be difficult in Information Science lectures, as the classes can be teacher-centred, with limited student participation and on-task peer interaction. Lecturers usually have limited awareness of students' knowledge base at both an individual or even class level (Exeter et al. 2010). Consequently, students become increasingly bored and engage in off-task behaviour, such as doodling on their lecture notes and using social media on their mobiles and laptops. It is plausible that integrating GSRSs in lectures to test and teach students' course knowledge will increase their engagement and learning and increase on-task mobile use behaviour.

Furthermore, according to the socio-cultural phenomenon known as the "Tall Poppy syndrome" (Feather 1989), New Zealand (and Australian) students are reticent to demonstrate their knowledge, ask and answer questions posed by the lecturer publically for fear of being perceived as attention-seeking and boastful by others, and ostracised by their peers (Tapper 2014). To conform to the social norms prescribed by the lecture environment, students rarely ask public questions and prefer to remain anonymous, particularly in large lectures (Exeter et al. 2010), thus likely reducing student engagement. Such an environment that supports the social ostracism of "tall poppies" (or high academic achievers) increases individual's decision-making avoidance (Dediu 2015), which may also negatively impact on deep learning. However, GSRSs' use allows students to remain anonymous while interacting with others and acquiring new knowledge (e.g. Wang 2015).

The use of educational games as learning tools (e.g. video games) is found to support the development of students' cognitive, motivational, emotional and social outlook (e.g. Papastergiou 2009; Siegle 2015). However, they are better suited to smaller classrooms with elementary and high school students (see, for instance, Jui-Mei et al. 2011) rather than university students who have to achieve specific learning outcomes through course work delivered in medium to large lectures.[1] Thus, in the present study, we distinguish between game-based learning, a pedagogical approach in which games are used to achieve educational outcomes through incidental learning, and gamification techniques, an integration of game elements in non-gaming systems (e.g. SRSs), which engage students and improve the experiential nature of active, intentional learning (Deterding et al. 2011; Ebner and Holzinger 2007; Huotari and Hamari 2012; Leaning 2015). Contrary to educational games, gamification elements are more easily incorporated into student response systems in mid to large lectures, leading to the development of GSRSs (Plump and LaRosa 2017). Although the gamification process is not new in education, the technologies that are supporting these interventions have been evolving, from single use to collaborative and distributed contexts (Holmes and Gee 2016). Thus, in the present study, we focus more specifically on the role of GSRSs on student engagement, motivation and learning.

Early use of gamification elements in education appeared to improve student response systems (SRSs), with promising outcomes, but limited impact on engagement and motivation (Wang 2015). SRSs are frequently used to display multiple-choice questions to offer opportunities for students to interactively answer quizzes in classrooms as part of a formative assessment regime (e.g. Sellar 2011). However, Kay and LeSage (2009) pointed out that the key challenges relating to the use of these technologies include the time needed to learn and setup these technologies, creating appropriate content, and providing

students with useful and timely feedback. With the wide spread use of gamification in the learning environment, there has been a noticeable shift from student response systems such as "iClicker" and "Poll Everywhere" to more contemporary game-based student response systems (GSRSs) such as Kahoot! and Socrative (Plump and LaRosa 2017; Wang 2015).

GSRSs are an example of a gamification approach that makes use of game principles and student response systems tools to support learning, engagement, motivation and fun during the learning process. The use of GSRSs in the form of gamification requires participants to activate previous knowledge and assess their performance as they play and learn the content of a subject (Méndez and Slisko 2013; Plump and LaRosa 2017). GSRSs enhance students' attention, motivation, engagement and enjoyment beyond traditional methods (Barrio et al. 2016; Wang and Lieberoth 2016). They also promote autonomy in learning as students can operate GSRSs on their mobile devices. Similar to earlier interventions involving SRSs, GSRSs improve overall class attendance (Cardwell 2007; Kay and LeSage 2009), but at an individual level, they also motivate students who may not normally participate in class discussion (Wang 2015). Furthermore, lecturers found GSRSs to be useful teaching tools in supporting personalisation of learning (Wang 2015). Thus, teachers have been encouraged to incorporate gamification into their classroom environments.

The potential effectiveness of GSRSs may be understood through Novak's (1998) model of meaningful learning, which distinguishes between students' deep and surface learning approaches. The model conceptualises learning as a process in which teachers select meaningful material for students based on their existing knowledge (see also Hay 2007). Next, teachers encourage students to engage in deeper learning rather than rote memorising, which occurs during GSRS use. This requires student to experiment, reflect and evaluate knowledge (see also Kolb and Fry 1975) and receive feedback through the follow-up (post-game) discussions. Students who have been taught through deep learning strategies (such as GSRS use) become highly engaged and, as a result, are able to apply their deep learning strategies to their study practices. For example, by relating course information to everyday behaviours and their own experiences, and through elaboration of the lecture content. In contrast, when lecturers promote shallow learning strategies and rote memorization strategies (associated with conventional, didactic teaching), their students are more likely to be disengaged and are less likely to have the "tools" and strategies they need for deep learning (Marton and Säljö 1976; Exeter et al. 2010). This theoretical model suggests that because GSRS promotes greater engagement, learning may increase beyond what would be expected from traditional methods.

To understand the potential effectiveness of GSRSs as learning tools, we can also generalise from game-based learning models, namely the Experiential Gaming Model (Kiili 2005). Similar to Novak's (1998) model of meaningful learning, this model posits that students learn through direct experience and reflective observation, which, in turn, induces experiences of "flow", characterised by (but not limited to) concentration and complete absorption (Csikszentmihalyi 1975, 1991), as long as the task difficulty is set slightly above that of the students' skill level (Kiili 2005), and the interfaces are user-friendly and do not detract attention from the task (Finneran and Zhang 2003). More specifically, students are presented with challenges that require completion based

on clear goals. They engage in the generation and testing of ideas during problem-solving, with a process monitored through feedback. Students then use the feedback to reflect on successful vs unsuccessful problem-solving strategies, and form schemas about how knowledge can be used in the future. Because GSRSs lack the game-play simulation, students are unlikely to experience some characteristics of flow (e.g. complete absorption and loss of self-consciousness); however, "game play" is not vital for this experiential learning process to occur as other learning platforms such as computer-based tutors also promote reflection on feedback and knowledge consolidation (e.g. Aleven and Koedinger 2002; Baker et al. 2010). Indeed, GSRSs facilitate the key experiential components of flow: challenges, clear goals, real-time feedback and playfulness (Kay and LeSage 2009; Malone 1980; Plump and LaRosa 2017), which increase concentration and sense of control and create the optimal learning environment.

One such GSRS, Kahoot! allows teachers to draw on course content to construct quizzes in which students participate as players in a "game-show" (Wang 2015), thus integrating gamification principles (e.g. audio and a score board with a points system) into an informal assessment procedure. Plump and LaRosa (2017) found that Kahoot! was easy for teachers to use in their classroom and required no prior training to implement. For instance, teachers can easily utilise Kahoot! to project quiz questions as regular lecture slides to which students respond using a web browser on their digital devices. Quizzes can be enhanced with images and videos, and the teacher is able to control the pace of play. Students are awarded points for answering questions correctly, and the timeliness of correct responses also impacts the points awarded. Displaying students' points on the screen motivates students to get to the top of the leader board. Kahoot!, like other GSRSs, fosters motivation and engagement (Barrio et al. 2016; Wang and Lieberoth 2016) and improves classroom dynamics as the system provides students with real-time feedback of their performance, and to some extent adapt teaching activities based on students' responses to quizzes (Plump and LaRosa 2017). Moreover, the anonymous aspect of Kahoot! also implies that students' privacy is not easily compromised. In addition, since Kahoot! incorporates social media, it enables students to create, share and exchange content with others in the class, and hence, fosters a sense of community (Wang 2015). Further, time constraints are minimal as Kahoot! collates and aggregates individual responses to questions within minutes. Therefore, teachers can focus on designing questions, administering the quiz, and, afterwards, facilitating discussion about the (in)correct responses.

The gamification ("game-show") process of Kahoot! does not change, which may increase teachers' concerns over student boredom. However, unlike other computer-mediated learning tools and games, the questions and problem-solving strategies vary with each Kahoot! usage based on the students' needs. Furthermore, Kahoot!s only last for a short duration. Kahoot! draws from Malone's (1980) "theory of intrinsic motivation" by challenging students with difficult problem-solving tasks in an audio-visually stimulating environment. The fantasy "game-show" environment further increases their absorption during problem-solving compared to other computer-mediated learning tools. Indeed, Kahoot! has a greater impact on interpersonal interactions than Socrative, allowing competition and discussion to occur between an entire class rather than in small groups (see, for instance, Méndez and Slisko 2013), and is therefore unlikely to induce boredom. Although complex concepts in the course material may increase students' frustration during Kahoot!, these experiences are unlikely to persist for a long period of time (e.g. Baker et al. 2010). In fact, temporary

experiences of frustration enhance enjoyability (Gee 2004). Kahoot! not only targets users' needs for challenge and fantasy, but also promotes students' sensory curiosity through surface-level gamification features (e.g. suspenseful music and colour displays), and their cognitive curiosity through the problem-solving process and real-time feedback. Therefore, Kahoot! was our chosen GSRS on which to explore the way such tools impact students' motivation, engagement and learning.

However, despite strong evidence that Kahoot! and other GSRSs increase student attention, motivation and engagement, it remains unclear whether Kahoot! leads to greater learning outcomes than traditional methods and SRSs (e.g. Méndez and Slisko 2013; Plump and LaRosa 2017). While previous work has examined students' feedback on the use of Kahoot! (Barrio et al. 2016; Wang 2015), such evidence has been driven largely from more quantitative measures, with limited reliability and validity. In addition, Likert-driven quantitative measures often provide insights into a phenomenon (what students think) rather than the depth (how students experience the phenomenon). The fact that Kahoot! is rarely researched in the university setting is also noteworthy, as at this level students are often more likely to be vocal in their learning experience. It would thus be pertinent to understand how such a tool would be received by university students, and particularly if there would be improvement in learning experiences where students tend to participate less. The present study utilised a qualitative inquiry to explore students' learning experience using Kahoot! The aim is to explore classroom dynamics, students' engagement, motivation and learning.

The remaining sections of this article are organised as follows. In the next subsection we present the study background, which leads to the identification and presentation of the research problem, and the research questions. The "Methods" section presents the details of the research methods and procedures. The "Results" section presents findings of the study. In the "Discussion" section, findings are discussed, limitations to the study are considered and implications of this work are highlighted. Finally, in the "Conclusion" section, concluding remarks are provided.

Background

Although research exploring the learning impacts of GSRSs is limited, its potential effectiveness as a learning tool has been supported by an extensive body of successful educational video and computer game adaptions. Papastergiou (2009) found that games improved students' knowledge of computer memory systems to a greater extent than other computer-mediated learning tools, namely, educational websites. The multi-sensory, experiential nature of games can enhance students' problem-solving and critical thinking skills (see for example, McFarlane et al. 2002). Games can enhance positive classroom dynamics (Rosas et al. 2003) and improve students' interactions with their peers and lecturers. Papastergiou (2009) also found that students rated games as more appealing and more valuable as an educational tool compared to other performance-tracking educational websites that contained the same content.

In addition to enriching learning, the effectiveness of GSRSs depends on whether students perceive the games as appealing, accessible, useful and of high quality. That said, in spite of the small "wear out effect" of long-term GSRSs use on students' communication and enjoyment (Wang 2015), students who continued to use GSRSs throughout a semester-long course reported their positive impacts on

learning and engagement, similar to the excited new users. Students also commented that, even after a whole semester of using a GSRS, they were still motivated to do additional study to prepare for weekly quizzes. More importantly, GSRSs, namely Kahoot!, provides lecturers with meta-cognitive support and encourages students to reflect on their understanding of existing concepts while helping them broaden their knowledge (Plump and LaRosa 2017) and facilitate their ability to argue their viewpoints on various topics (Méndez and Slisko 2013). Kahoot! is also increasingly used as a formative assessment tool in medical undergraduate programs and was found to support learning retention (Ismail and Mohammad 2017).

In fact, Wang and Lieberoth (2016) dissected Kahoot! to explore which gamification elements positively impact students' experiences finding that the full Kahoot! experience, rather than any single component, accounted for students' increased concentration and enjoyment. The student points system was the strongest predictor of engagement as students' reported an increase in their pulse. However, overall, the presence of audio increased student motivation and classroom dynamics, above and beyond that of the points system. In fact, teachers may use Kahoot! as a reflective tool to validate students' learning and to monitor overall class progress, as well as individuals' learning trajectory. For instance, the utilisation of Kahoot!s in Information Science lecture sessions at our institution over the past 2 years suggest that such tools excite students to actively engage in lectures and contribute to the learning environment (Licorish et al. 2017).

That said, despite increasing utilisation of GSRSs, it remains unclear the extent to which GSRSs can improve learning beyond what would be expected from conventional teaching methods. In addition, it is still not known whether GSRSs can improve students' academic performance (Randel et al. 1992). Furthermore, there is evidence of a reduction in classroom dynamics with repeated use of Kahoot!, which may negatively impact learning. Wang (2015) found that regular use of Kahoot! (one session per lecture for a whole semester) resulted in a small "wear-off" effect of positive classroom dynamics in software engineering students. Only 52% of students agreed that Kahoot! increased positive, topic-relevant communication with classmates compared to 67% of first-time users. Although the students were similarly engaged and motivated compared to novice Kahoot! users, the "wear-off" effect of classroom dynamics has previously increased students' state of boredom, which once manifested, may become persistent across learning environments, and consequently decreases students' learning ability while increasing problem behaviours (Baker et al. 2010; Squire 2005).

Another study reported that Socrative, a similarly designed GSRS to Kahoot!, improved classroom dynamics and knowledge awareness, but students disagreed that Socratives enhanced their ability, concept understanding and test practice procedures (Méndez and Slisko 2013). Students also implied that Socrative was not suitable for learning difficult material, potentially because it does not allow for open-ended questions, short statements as responses or discussions of relevant theory in sufficient depth due to time constraints. However, the associations between these negative aspects of Socrative and consequences for student learning remained unclear as previous negative reports were only collected through open-ended response questions rather than semi-structured interviews. Nonetheless, concerns have also been raised in the literature about the use of Kahoot! in teaching of complex concepts, especially subjects that can require competition and high cognitive load of the students (see for example, Ismail and Mohammad 2017).

In fact, the simple Likert-scale measures (on their own) that are regularly used for GSRS evaluations are not necessarily adequate for understanding the complexities in human behaviour, and particularly those related to students' engagement, motivation and learning (e.g. Ke 2009). The literature suggests that exploring users' experience with game-based technology may be better suited to qualitative survey-based approaches rather than quantitative measures (Nacke et al. 2010). In fact, Wang et al. (2009) found that users' experience of perceived playfulness using GSRSs, including attention and focus and intrinsic enjoyability, influenced intention to use, but such issues may not be entirely teased out with quantitative measures. Furthermore, although Wang (2015) utilised GSRS Likert-scale evaluations with students' open-ended comments, the data were only analysed quantitatively, and thus, it remains unclear whether semi-structured interviews were conducted to generate answers to specific questions, necessitating further exploration of whether students' perceptions of GSRSs remain the same or can change over time.

Interestingly, the Likert scales were also not always consistent with students' open-ended comments (Wang 2015). For instance, while GSRSs are said to enhance communication, students explained that impending assessments and a desire to focus on quiz content reduced their willingness to communicate with other students. There is thus need for exploratory studies to unpack *if* and *when* GSRSs help, in support of our understanding of classroom dynamics and the way games enhance students' engagement, motivation and learning. Such insights would direct the use of GSRSs in teaching, and particularly at the tertiary level. We broadly conceptualised classroom dynamics as the interaction between students and lecturers. Student engagement relates to the level of attention, curiosity, focus and interest that students show during the course. Motivation is the persuasion to be engaged and interact in the classroom. Learning is defined as the knowledge and skills that students attain that are directly attributed to their involvement and participation in the course.

Overall, our research aims to contribute to the better understanding of accrued benefits of using GSRSs in learning and to gauge the extent to which the use of Kahoot! can enhance students' learning experience. More specifically, our objective was to understand how students experienced the use of Kahoot! and to explore the extent to which this interactive technology influences classroom dynamics, engagement, motivation and learning. In our study, we addressed the following four research questions:

RQ1. How does Kahoot! influence classroom dynamics?
RQ2. Does the use of Kahoot! influence students' engagement, and how?
RQ3. In what ways does the use of Kahoot! influence students' motivation towards learning?
RQ4. How does the use of Kahoot! enrich learning experiences?

Methods

We employed a qualitative approach to address the four stated questions. We believe that a qualitative research approach is relevant to utilise in this study because the phenomenon being studied is not easily distinguished from the context in which it is observed (Yin 2013). Using an explorative case study, we intend to unravel complex perceptions and issues relating to the use of Kahoot! in the context of students' engagement, motivation and learning. This approach is used to enrich the insights gained from the

exploration of the literature and provide deep levels of interpretation for the phenomenon under consideration. We provide details around the design of Kahoot!, our sampling and participants and data processing and analysis in the following three subsections.

The Design of Kahoot!

The game-based student response system (Kahoot!) was used as a part of a third-year course on Information Systems Strategy and Governance in the second semester of 2016 (between July and November). This tool was used in four (4) different ways during seven (7) different lectures by teaching staff (out of 13 lectures altogether), with a duration of about 30 min on average (students could also play Kahoot! outside of the classroom). These include the following: to quiz students on various topics to understand their competence before tailoring lesson plans, for exploring students' knowledge of topics after they were delivered in lectures, to help students to validate their comprehension and understanding of topics by having them design their own Kahoot! assessments which were then collectively played, and for fun where the focus was on topics unrelated to the course (e.g. sports). Kahoot!s designed by teaching staff were typically 10 to 12 questions long (e.g. covering the IS Cost recovery topic) while those designed by students were eight (8) questions long (e.g. covering IT-supported work). Students designed nine (9) Kahoot!s altogether. Thus, over the course, students played seven staff-created Kahoot!s and nine student-created Kahoot!s. Moreover, the Kahoot! game environment was designed with many interactive features (including suspense music), where students used mobile devices (smartphones, tablets and laptops) to join the games and answer questions, and responses to their choices were visualised (illustrated in Fig. 1).

Sampling and participants

At the end of the course, students were interviewed using a semi-structured approach, where purposive non-probability sampling was used to recruit students enrolled in the course. The study was announced and its purpose explained during the final lecture, having received human and behavioural ethics approval from the university in which the study was conducted.

Fourteen students (10 male, 4 female) agreed to participate in the study (of 48 students altogether). The sample size is deemed adequate for the chosen (purposive) sampling method as the possible pool of participants is already restricted (Marshall 1996). Students agreeing to participate were asked to spare 20 min of their time for the semi-structured interview where they were asked questions relating to the use of "Kahoot!" during the course (interviews took between 15 and 20 min). The questions were focused on understanding students' experiences using Kahoot! and the tool's influence on classroom dynamics, their engagement, motivation and learning. Students were also asked to give suggestions for alternative uses of "Kahoot!" and describe their general experience with the tool. Sample questions included "How do you feel about the changes in the Information Systems Strategy and Governance classroom dynamics brought about by Kahoot!?" and "Do you feel that Kahoot! increase/decrease your engagement during the Information Systems Strategy and Governance course, and how did it increase/decrease?"

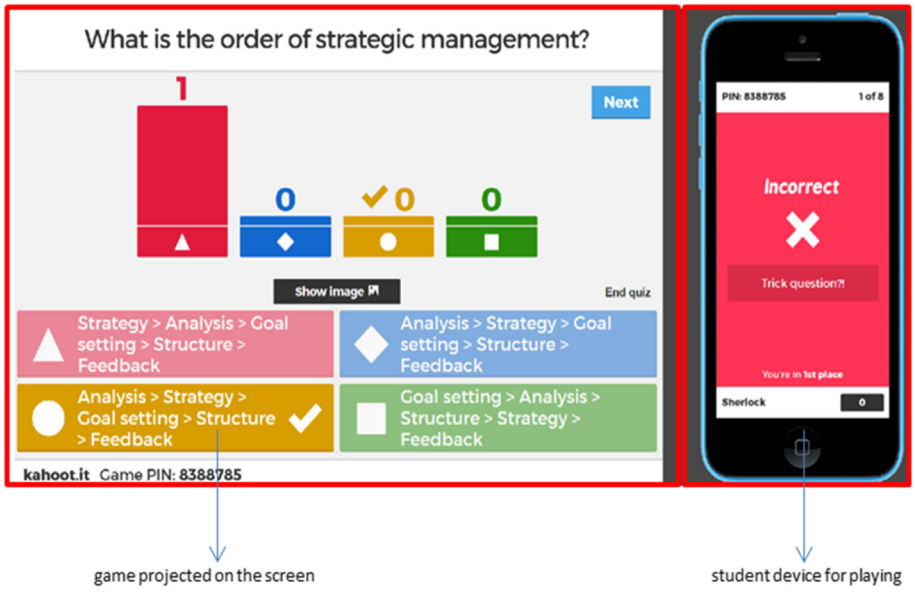

Fig. 1 Game show interface projected on screen and on mobile device

Data processing and analysis

Students' responses to the interviews were transcribed by the fourth author, i.e. verbatim. These transcripts were then verified by the first author. The transcripts were identified by author ID; interview time, questions and responses, and students were treated as the units of analysis. Thereafter, our analyses of the content were performed.

We adopted an inductive (bottom-up) approach to content analysis to test whether clear themes relating to classroom dynamics, engagement, motivation and learning appeared in the data (Patton 1990). The procedure involved open coding where the interviews were read and re-read for familiarisation and initial codes were identified based on explicit, surface-level semantics in the data, rather than implicit responses and preconceptions (see Braun and Clarke 2006). Through axial coding, codes were recombined, and connections were formed between ideas. Then, we used thematic mapping to restructure specific codes into broader themes. Finally, following Braun and Clarke's (2006) selective coding procedure, the resulting themes were refined and organised into a coherent, internally consistent account, and a narrative ("story") was developed to accompany each theme. Themes were extracted from answers provided in response to interview questions, which targeted understandings around *classroom dynamics*, *students' engagement*, *motivation* and *learning*. The outcomes were used to answer the four research questions (RQ1–RQ4).

Initially, descriptive statistics were used to summarise participants' demographic information, including gender distribution (noted above), ages, years of study, hours spent studying and performance in the course. Performance was measured based on coursework (i.e. case critique, case study and class project) and final exam grades, where students tended to perform better in the former assessment. These assessments are scored out of 100% in Table 2. Of note, however, is that there is disparity in the number of observations for males and females (refer to Table 1), so these statistics are not used strictly to examine statistical significance between these two groups. We

Table 1 Detailed demographic information for participants

Participant (student)	Age	Gender	Duration of study	Course	Hours dedicated to course overall (weekly)
1	22	Male	4	Information Science	6
2	22	Male	4	Information Science	6
3	21	Female	4	Information Science and Marketing	5
4	21	Male	4	Information Science	3
5	23	Male	4	Information Science	2
6	22	Female	4	Information Science	5
7	20	Male	3	Information Science	8
8	20	Female	3	Information Science and Management	4
9	22	Male	4	Information Science, Computer Science and Design	11
10	20	Male	3	Information Science	6
11	19	Male	2	Information Science and Accounting	3
12	22	Male	3	Management and Information Science	10
13	21	Male	4	Information Science, Economics and Management	8
14	24	Female	2	Information Science	9

provide detailed demographic information for the 14 participants in Table 1 and summary statistics in Table 2, which are used to support the contextualising of our result in the next section.

Results

As noted in the "Background" section, we broadly conceptualised classroom dynamics as the interaction between students and lecturers. Student engagement relates to the level of attention, curiosity, focus and interest that students show during the course. Motivation is the persuasion to be engaged and interact in the classroom. Learning is defined as the knowledge and skills that students attain that are directly attributed to their involvement and participation in the course.

Our aim was to examine the extent to which Kahoot! influenced classroom dynamics, students' engagement, motivation and learning (in answering RQ1–RQ4). Findings from the analysis revealed four major themes related to students' experience in the use of Kahoot! in the classroom: (1) attention and focus, (2) interaction and engagement,

Table 2 Descriptive statistics for participants' demographics

Gender	Statistic	Age	Years of study	Hours of study each week	Performance (%)	
					Coursework (/100)	Exam (/100)
Overall	Mean	21.4	3.4	6.1	81.7	73.4
	Std. Dev.	1.3	0.8	2.7	8.8	15.2
Male	Mean	21.2	3.5	6.3	81.5	73.8
	Std. Dev.	1.2	0.7	3.0	10.0	15.1
Female	Mean	21.8	3.3	5.8	82.1	72.4
	Std. Dev.	1.7	1.0	2.2	5.8	17.9

(3) learning and retention of knowledge and (4) fun and enjoyment. The first three themes here cut across those that were planned for the study (revisited above), with learning particularly influencing retention of knowledge, and all other themes evident as defined. Fun and enjoyment was an unexpected theme and explains the feeling of leisure and enjoyable distraction that was experienced by students. Three of the themes extracted from the data (i.e. attention and focus, interaction and engagement, and learning and retention of knowledge) were prevalent in the responses of the 14 participants. Moreover, the theme of fun and enjoyment was identified in the responses of 12 of the 14 participants. We examine our outcomes for each of the four themes in the following subsections.

Attention and focus

All participants (14) seem to agree that the use of Kahoot! triggered positive attention and focus in the classroom. Some suggested that interacting with Kahoot! captured and sustained their attention, as well as enabled them to take a break in the lecture and provided a point of difference.

Attention

While the use of Kahoot! itself was an enjoyable activity, students said that Kahoot!s motivated them to pay attention during the lecture. The deployment of Kahoot! also motivated students to closely examine lecture material in order to prepare for the Kahoot! and answer questions correctly.

> I guess it keeps you more aware in a way but you've got to listen throughout the lecture to know what the answer is in Kahoot! which is also a good thing. So you're always focused if you want to do well in Kahoot! (Student 7)

Having a break

A major barrier to staying focused in class was the length of the lecture as well as the time of day in which the lecture took place. Our analysis revealed that 9/14 participants highlighted the importance of having a break during lectures in order to balance and sustain a desirable level of attention during lectures. They reported that Kahoot! facilitated breaks in positive ways. Ten of the 14 respondents described staying focused in a 2-h lecture as challenging, with some describing the experience as tedious or boring. Taking a break to engage in a fun activity allowed students to feel refreshed, providing timely relief at the halfway mark of the lecture and re-energising students for the second hour. In addition to facilitating breaks during lecture, the use of Kahoot! also created richer variation in lecture delivery, enabling a moment of fun while continuing to engage with lecture content, only in a more light hearted way.

A point of difference

Participants referred to Kahoot! as a unique lecture experience that is enjoyable and stimulating to learning. Compared to engagement in other lectures, students mentioned that learning with Kahoot! was a rewarding lecture experience that is captivating and desirable.

> What's been good is that it was different… it allowed people to sort of sit back and go well this isn't how lectures usually run. So it did capture everyone's attention straight away. (Student 1)

Interaction and engagement

Our analysis suggest that Kahoot! gave students more opportunities to interact and engage with the lecturer, peers and lecture content by providing a fun platform on which to engage. All 14 participants reported that Kahoot! positively impacted engagement in the class, and 13 of the 14 participants said that Kahoot! increased their interaction and involvement in the lectures. Key points that emerged from the data were the importance of discussions, competition and anonymity.

Interaction and discussion

Participants reported that the use of Kahoot! fostered interactivity and engagement during lectures, through answering questions, participating in quizzes, and discussions triggered by Kahoot!. The use of Kahoot! encouraged wider participation in class as opposed to conventional classrooms where discussions are often dominated by a few extraverted students. The wider student participation in the class also fostered deeper engagement in the learning environment.

> …Kahoot! gives me a platform that I can express what I think … even though it's silent … I still give ideas… (Student 5)

Kahoot! fostered wider and active student participation, and yet provided students with the opportunity to retain their most desirable personal choice of participation. Participants reported that when engaging with Kahoot!, they interacted more with peers around them and with the lecturer during and after lectures than they normally would in any other lecture. Participants pointed out that with Kahoot! in the classroom, they could decide on the level of interaction that they felt comfortable with, either participating anonymously or overtly with friends, other classmates, the lecturer or with the whole class.

> Yes it made it more interactive. I supposed I don't talk in any other class … [I talked] with my classmates more than the teacher. I probably wouldn't have volunteered any information to the teacher. But I definitely did have more discussions in terms of the actual content with people around me than I did in other classes (Student 6)

Competition

Nine participants discussed the competitive element of Kahoot! in relation to their interaction and engagement. Many respondents liked the competitive aspect of Kahoot!s, seeing it as a motivating factor to participate, encouraging them to think critically, increasing their participating energy levels and creating a lively classroom dynamic. Competition was viewed as a strong motivator, with one respondent describing how students like to "perform" and another expressing their motivation to reach the top of

the scoreboard and be the best in the class. Having a desire to win encouraged many students to prepare beforehand and engage with the material. It also seems to have been an icebreaker for many students, encouraging them to interact with their peers.

> …it was almost a sense of, not just competition, I want to be the best, but also comradery, hey do you think it's also the square, oh I hit the wrong one what did you go for? (Student 9)

Despite the positive experience associated with the competitive nature of Kahoot!s' utilisation, two participants felt that the use of Kahoot! had a negative competitive effect on their learning experience. They mentioned that negative aspects of competition came into play when students focused more on the competition and having fun rather than learning. In their desire to compete, some students rushed to answer questions, not taking the time to understand the questions or the answers.

> I enjoyed it, I think towards the end we probably all got a bit distracted with names and being competitive, I think sometimes you lose sight of trying to learn new things because you are just trying to win and have fun with friends instead of learning (Student 8)

Anonymity

While viewed as a negative aspect of participation in technology-mediated learning environments, allowing anonymity can foster deep and enriched participation. Providing anonymous participation in a learning environment can encourage wider participation as it inculcates a sense of safety and privacy (White and Dorman 2001). The way Kahoot! was used in the course allowed students to enter a name of choice into the system each time they participated. Students could decide if they wished to remain anonymous or identify themselves. Anonymity allowed students' to feel safer when responding to questions. It also allowed students to focus on comparing the content of Kahoot! and differences of opinion, rather than comparing students' aptitudes. This encouraged participation, as students were able to take part without feeling that they were being judged for answering correctly or incorrectly. Several respondents described funny names within the Kahoot! adding positively to the element of fun and social learning in game-based environments (Squire 2011). However, this also had the potential to shift the focus away from learning as students became distracted and no longer took the Kahoot! seriously.

> …so because it's anonymous it never creates conflict … so if the system is anonymous that's good for students. (Student 5)

Learning and knowledge retention

Nine out of the 14 participants stated that Kahoot! was a useful learning tool, and all 14 described Kahoot! as having a positive influence on their learning experience. Throughout the interviews, participants made positive references to how Kahoot! supported their learning. They stated that engaging with Kahoot! during lectures helped them not only to remember previously covered material but to understand new

perspectives. They also reported that Kahoot! increased their knowledge. Knowing that there would be a Kahoot! in class also motivated several students to prepare and review material in order to do well in the Kahoot!. In particular, students enjoyed Kahoot!s that were relevant to the course, explored complex concepts and offered insight into applications of theory. Key benefits that participants discussed were how Kahoot!s aided revision, generated discussion and helped them to retain knowledge.

> When you get a question it does help you, you've got to think about the answer, you've got to look at lectures to prepare for it… so that's part of revision as well (Student 3)

Revision

Participants felt strongly that Kahoot! could be used for revision, with 12 participants seeing Kahoot! as a useful revision tool. In fact, three participants had used Kahoot! as a revision tool for exam preparation. Participants commonly felt the best use of the tool was to review lecture content and key topics, with Kahoot!-related course content favoured over those unrelated to the course. By repeating the content in a novel way through Kahoot!s, students felt they were more likely to remember the concepts. In particular, participants mentioned Kahoot!s being useful for allowing a deeper understanding of theoretical concepts. Kahoot! also offered a brief and concise understanding of the basic concepts in the course, which was then reinforced and enriched by a class discussion that encouraged more in-depth thinking.

> It helped with the revising what we'd already been taught more so than actually learning the stuff because you were already asking questions about things you'd already taught us [and] I guess that does help in the long run of actually understanding (Student 7)

Discussion

Eleven (11) participants' responses indicated that the discussion generated by Kahoot! was often where the most valuable learning took place. Specific benefits to post-Kahoot! discussions provided perspective, highlighted diverse opinions and allowed students a chance to evaluate their knowledge in comparison to other class-mates. Kahoot! and the following discussion also gave students feedback to immediately correct their own mistakes, knowing if they got an answer right or wrong, and more importantly, why. Exploring the answers and understanding why they were right or wrong generated a deeper understanding that strongly aided participants' engagement and retention of knowledge.

> The Kahoot! itself almost seems like a fun tool to get people back engaged and then the conversation afterwards is where the learning actually occurs. You're not actually learning from it directly but more indirectly from the discussion afterwards (Student 4)

Increasing and retaining knowledge

Nine participants mentioned that Kahoot! helped them remember information during and after class. A few students also felt that Kahoot! added to their knowledge, as when new information was introduced they were more likely to remember it through a Kahoot!. Regarding knowledge retention, respondents appreciated that it was a quick and simple way to refresh their memory and continue to engage with the material. Respondents indicated that within the 2-h lecture, a lot of material was presented to them, making it hard to retain key concepts and facts. Kahoot!s supported students to re-grasp and retain key points from within the lecture, providing a reminder of what was covered. Participants also noted that they were more likely to remember Kahoot!s that they got wrong, as they had to consider why they got the question wrong and seek to understand the correct answer.

> It's often good to go back because then ones you got wrong, you remember them because you are like oh I got that one wrong and it's easier to remember them (Student 12)

Fun and enjoyment

As a game-based student response system, fun and entertainment lie at the core of Kahoot!. The data showed that respondents enjoyed the Kahoot!. Twelve participants specifically pointed out that Kahoot! was fun. The element of enjoyment and fun underlies the positive aspects of all three aforementioned themes. However, fun and enjoyment were also alluded to as being a contributor to several negative impacts of Kahoot!.

> It was definitely a positive interest … it wasn't a standard boring lecture where you could sit there and read the notes later on….. (Student 1)

The firm preference for using Kahoot! among participants was attributed to the game features. Participants said they enjoyed the game, they liked the use of it in class and they enjoyed the course because of the Kahoot!. Further, the aspect of fun and enjoyment seems to have helped a number of students overcome barriers to interaction that they face in a typical lecture environment. Kahoot!s as an energetic, fun, class-wide activity (that did not require students to identify themselves or speak in front of the class) served as an icebreaker for many respondents.

> It was just a fun way of interacting and learning the stuff and seeing if you knew your stuff with the quizzes and stuff for me that was useful (Student 7)

That said, two (2) participants reported a mixed response, and one (1) of the two participants felt the aspect of fun had a negative impact. Throughout the data, it is evident that striking a balance between fun and learning is vital to effectively using Kahoot! as a valuable tool in the classroom. It seems as though participants reported negative impacts when the focus shifted too much in either direction. Respondents specifically described whacky or funny names in the Kahoot!s as sometimes distracting. They also felt that Kahoot!s involving guessing were purely for the sake of having fun

and did not contribute to their learning. Only one participant specifically mentioned that they enjoyed fun 'off-topic' Kahoot!s, with most participants feeling such Kahoot!s were irrelevant and an inefficient use of class time.

> It didn't feel directed enough … I was kind of like why are we doing this, it just seemed like a random fun activity… I mean it's fun but there's not point to it in the grand scheme of things. (Student 6)

Discussion

Learning and instructional science research has established that gaining students' attention and keeping them engaged in class is central to stimulating their learning, and low levels of attention span is linked to poor performance (Gagné 1985; Gagné and Driscoll 1988). Maintaining students' attention and engagement can be difficult in Information Science lectures, which may not be conducive to establishing positive student-lecturer interactions and student participation. In addition, when students do not participate openly, this could be problematic given that motivation and engagement strongly influence learning and may be critical to academic success (Martin 2008; Pintrich and Schrauben 1992). Therefore, higher education institutions (including institutions in New Zealand) have started deploying learning technologies, such as GSRSs, to present lecture content in a novel manner, to encourage students to participate in class anonymously and to provide them with more meaningful revision methods (Licorish et al. 2017). Teachers and course coordinators integrate GSRSs into lectures with a view to enhance student motivation, engagement and in turn deeper learning. Beyond such interventions, with maturity in learning technologies, mobile and ubiquitous devices are becoming widespread in contemporary classroom settings and are being integrated into many aspects of classroom teaching to encourage students' engagement, motivation and learning (e.g. Brandford-Networks 2013).

Over the last decade, there has been an increasing use of game-based student response systems (GSRSs) to support attention, motivation and engagement. However, there remained a conflict in previous research as to whether GSRSs, namely Kahoot!, improved student learning and retention. Thus, there was a need for a qualitative exploration of students' learning experiences using Kahoot!, particularly in the domain of Information Science at the university level. The current study explored how the integration of GSRSs and Kahoot! contributed to students' motivation, engagement and learning in the domain of Information Science, shedding light on how and when Kahoot! has a positive impact on students' learning experiences. We revisit our outcomes to answer our four research questions in this section and outline potential implications for research and practice. We first answer the research questions and discuss the outcomes in relation to previous works in the "Discussion" section. Next, we consider the limitations of the work in the "Limitations" section. Finally, we evaluate the implications of the analysis in the "Implications and future work" section, and also outline avenues for future research.

Discussion

RQ1. How does Kahoot! influence classroom dynamics?

We observed that Kahoot! gave students more opportunities to engage with the lecturer, peers and lecture content. It also helped in creating a learning experience that was

described as "fun", which contributed to useful classroom engagement dynamics. This was a particularly different learning experience to the traditional "chalk and talk" method that students have been exposed to in other courses (e.g. Graham 2015; Roehl et al. 2013). The findings substantiate previous research in supporting the use of Kahoot! in fostering our understanding of classroom dynamics, enhanced lecturer-student engagement, and more constructive discussions with peers (Plump and LaRosa 2017; Wang 2015). When students are engaged, they exhibit curiosity in the learning content and maintain focus during class sessions. Consistent with Wang (2015), findings from our study suggested that maintaining anonymity is critical for facilitating engagement among students who might not be actively participating in classroom discussions. Findings also suggested that the employment of Kahoot! led to excessive competition among students and to some extent, invoked negative feelings. That said, notwithstanding such feelings, we observed that the desire to perform resulted in increased learning (or knowledge acquisition). While Kahoot! is known as a great tool for doing revision before formal assessments, it is interesting to know that this tool may also promote class discussion after the game, which may ultimately enhance students' ability to remember concepts at a later stage. Thus, beyond increased engagement and a shift in classroom dynamics, the drive to perform, and ultimately increase learning are positive effects of Kahoot! use during lectures.

RQ2. Does the use of Kahoot! influence students' engagement, and how?

Students felt that Kahoot! captured their focus (or attention) and interest during the course but was also timely for allowing breaks. This was particularly necessary for reflection on lectures and class discussion, especially in lectures that were longer than 1 h. In the same vein, the need to be attentive to perform well in Kahoot! helped students to maintain interest in the lessons during lectures. Their willingness to perform was also influenced by the level of anonymity afforded by Kahoot!, which allowed students to remain focussed on comparing the content of Kahoot!s and differences of opinion, rather than comparing other students' aptitudes. Consistent with Experiential Gaming Model (Kiili 2005), these findings further emphasise the importance of GSRSs, like games, for generation and testing of ideas during problem-solving, monitoring one's knowledge through feedback and discussion, and encoding and storing this knowledge for future use (e.g. Ke 2009; Papastergiou 2009). These findings also somewhat contradict the idea that students only learn through trial and error when using GSRSs (Kiili 2005). In fact, our findings show that in view of exploring answers to questions and understanding why they were right or wrong, students generated a deeper understanding that strongly aided their engagement and ability to remember. This outcome is interesting, in that there is indication that in-depth learning results from the discussion after playing Kahoot!; even after the game is over. To this end, the design of questions for the Kahoot! game and subsequent discussions are likely to be integral to in-depth learning. Thus, the instructor's design of questions and his/her skills in leading discussions are important factors in getting the most values out of an online tool like Kahoot!. While the game is likely to provide an atmosphere that would lead to potentially more relaxed and attentive students, similar learning may also result in the absence of Kahoot! if the instructor thrust is towards this cause. Students' reports of the importance of the post-Kahoot! discussion is consistent with findings from previous "blended learning" interventions (i.e. e-learning and teacher instructions) which indicate that autonomous,

student-driven online learning is more effective when staff members interact with students regularly using the platform and provide prompt, detailed and summative feedback (Poon 2013; Yen and Lee 2011).

RQ3. In what ways does the use of Kahoot! influence students' motivation towards learning?

Our outcomes show that Kahoot! motivated students to be engaged, and encourage interaction in the classroom (both student-student and student-lecturer). Students were motivated to be attentive on the backdrop that they wanted to perform well in Kahoot!s. This in turn motivated students to engage with the lecturer, peers and lecture content. Kahoot! also motivated competition in the classroom, where students were driven to see their names at the top of the leader board, and thus, were more attentive during lectures and related discussions. These effects of enhanced attention and "healthy" competition are consistent with Wang's (2015) findings.

However, we observed that students drive to perform well in Kahoot! and the use of inappropriate names could invoke negative feelings towards the tool and increase distraction. Furthermore, Kahoot!s involving guessing do not maintain students' motivation towards learning, as students perceive these to target fun. However, third year university students are eager to focus on subject-relevant content, and so, find little value in content delivered that is off topic. If instructors want to incorporate Kahoot! in their lectures, they might want to minimise these negative effects. For instance, teachers could reduce the length of Kahoot! sessions but devote more time to the post-Kahoot! discussion of the answers and the problem-solving strategies taken to achieve the correct answers. Teachers should also achieve a balance between testing students on new versus recently acquired content to maintain their attention, and maximise Kahoot!'s effectiveness as a learning tool.

RQ4. How does the use of Kahoot! enrich learning experiences?

Student conceded that Kahoot!s' use in the course had a positive impact on the knowledge and skills they attained. Students noted that the drive to increase their attention and interaction strongly supported their learning in the course. This supports previously documented positive effects of GSRS use on learning (Ismail and Mohammad 2017; Méndez and Slisko 2013; Plump and LaRosa 2017) and is consistent with Novak's (1998) model of meaningful learning. Lecturers are responsible for establishing an environment in which deep learning (relating course information to everyday behaviours and their own experiences) occurs through Kahoot! use, thus providing students with the tools to adopt these learning strategies in their assessment and study. Indeed, when students did not perform well in Kahoot!s, those specific Kahoot!s were used to drive revision efforts, in view of overcoming learning deficiencies. In addition, Kahoot! offered students the opportunity to focus on specific relevant content, when a large amount of materials were delivered in lectures, which, again, is consistent with Wang's (2015) findings. However, as student assessment approaches, Kahoot! may play more of a supporting role in the revision process as students may focus more on studying lecture content than interacting with other students and the lecturer. Kahoot! not only increases learning and the desire to remember lecture content during revision, but increases knowledge retention over the course of the lecture, i.e. students

report that learning took place between Kahoot! and the discussion that followed. Having the teacher explain the theory and reasoning behind the correct answers meant that the information was more strongly encoded in long-term memory. Thus, students may not require additional revision to remember and correctly report relevant content during assessments.

Limitations

While we have provided a number of insights in this work, we acknowledge that there are a number of shortcomings that may potentially affect the validity and generalizability of our study outcomes. Firstly, our sample is relatively small, and thus, our outcomes may not generalise to all lecture environments. That said, given the theoretical saturation observed for the themes revealed in this study, we believe that our outcomes may generalise to third year Information Science university students. Second, the students' perceptions around the use of Kahoot! may be influenced by their background, and thus, this is to be considered when interpreting our findings. Third, Kahoot! was used in four (4) different ways during seven (7) different lectures by staff, with a duration of about 30 min on average. Students also designed and played a further nine Kahoot!s. Such use of Kahoot! may not represent all possible scenarios, and thus, students' perception may vary given other experiences with the tool. That said, we have carefully considered how Kahoot! was used with a view of stimulating classroom dynamics, students' engagement and motivation, and ultimately, their learning, and so we believe our approach to the use of this tool was exhaustive. Finally, since the study was qualitative in nature, it is limited in its generalizability to other settings, beyond the lessons learned. Future work will focus on deploying Kahoot! with a large number of students and different subjects and assess students' experience while learning in this environment.

Implications and future work

On balance, Kahoot!s with the highest impact on classroom dynamics, student engagement, motivation and learning seems to be those that focussed on relevant course topics, and where there is little use of excessively distracting names and students' behaviours. In fact, consistent with Papastergiou's (2009) findings, students noted that Kahoot! improved classroom dynamics, engagement, motivation and learning beyond what would be expected from traditional teaching methods (e.g. normal PowerPoint slides and chalk and talk). However, we were not able to quantitatively examine such differences with the data collected; we hope to do so in future work. The themes identified support the previous studies that have found a positive effect of GSRSs on, for instance, classroom dynamics, motivation, social interaction, attention, (Méndez and Slisko 2013), willingness to prepare for class and learning (Plump and LaRosa 2017; Wang 2015; Wang and Lieberoth 2016).

This confirmation suggests that Kahoot!, and the use of games and gamification in general, have a positive influence on classroom dynamics, students' engagement and motivation, and ultimately, their learning. While our evidence here is positive for informing pedagogy, and particularly in terms of identifying the suitable contexts for which the use of games and gamification are beneficial, challenges are still likely to remain in terms of the time needed to learn and setup these technologies, creating

appropriate content, and providing students with useful and timely feedback. Indeed, time constraints for Kahoot! sessions in lectures were reflected in some of the negative feedback from students, who felt that the recreational use of Kahoot! restricted content coverage and wasted valuable lecture time. Therefore, it is important for teachers to carefully structure lectures so that Kahoot! time is appropriately allocated. Educators are thus encouraged to balance these challenges in introducing game-play sustainably, particularly in light of the potential benefits that could be derived through the use of games during learning sessions.

In terms of our methodological contributions in this work, this study attempted to show rigour by employing a systematic procedure for data coding and thematic extraction that researchers can follow in the future (Cope 2014). The findings of this study also reflect high transferability and auditability (Daniel 2018), as the lessons learned from this work can be useful in similar GSRSs contexts (e.g. Socrative, Quizlet and Buzz!) and can be successfully implemented into university lectures in the future. From an applied perspective, and particularly towards improving lecture practice, the results of the present study also provide guidelines as to when and for how long Kahoot! can be a useful learning tool.

Our future research will involve a large-scale deployment of Kahoot! to examine the efficacy of this tool in enhancing student learning outcomes, using quasi-experimental design as well as exploring the experiences of teachers in using Kahoot! in enhancing their teaching effectiveness. We also plan to administer a web-based survey to gather quantitative evidence to triangulate our outcomes, and particularly those around the specific aspects of GSRSs that contribute to the enrichment of learning over the use of the "chalkboard" or "PowerPoint slides". Furthermore, there is scope to correlate our outcomes with those provided by learning analytics tools.

Conclusion

There is growing interest in understanding how students' motivation and engagement influence their learning. On the promise that technology may aid this process, institutions of higher education are deploying learning technologies with a view of encouraging student motivation and engagement, spanning interventions related to lecture content and assessments, including revision for exams. Educational games and gamification in particular are held to support the development of students' cognitive, motivational, emotional and social outlook. GSRSs stand at the heart of such interventions and are said to provide students with real-time feedback and require no prior teacher training to implement. In contrast, SRSs are said to pose challenges related to the time needed to learn and setup these technologies, creating appropriate content, and providing students with useful and timely feedback. One such GSRS, Kahoot!, fosters motivation and engagement through gamification, where teachers are able to provide real-time feedback to students, and to some extent adapt teaching activities based on students' responses to quizzes. Students are also afforded anonymity when playing Kahoot!, which reduces the risk of their privacy being compromised. Furthermore, because Kahoot! incorporates social media, it enables students to create, share and exchange content with others in the class, and hence fosters a sense of community. Notwithstanding the positive reports about Kahoot!, these outcomes were largely derived through quantitative means and rarely focus on university students. To this end, there is need for deeper insights around the

effectiveness of this tool, and particularly for older students. We addressed this gap and conducted interviews with university students to understand Kahoot! further, including how this technology informs learning, and the conditions under which it provides the most value to teachers and students.

We observed that Kahoot! gave students more opportunities to engage with the lecturer, peers and lecture content. It also helped in creating a learning experience that was described as "fun", which contributed to useful classroom engagement dynamics. Students felt that Kahoot! captured their focus and interest during the course, but was also timely for allowing breaks. This was particularly necessary for reflection on lectures and class discussion, especially in lectures that were longer than 1 h. Students' willingness to perform was also influenced by the level of anonymity afforded by Kahoot!, which allowed students to remain focussed on comparing the content of Kahoot!s and differences of opinion, rather than comparing other students' aptitudes. Our outcomes show that Kahoot! motivated students to be engaged and encourage interaction in the classroom. Student conceded that Kahoot!s' use in the course had a positive impact on the knowledge and skills they attained. Students noted that the drive to increase their attention and focus and interaction and engagement strongly supported their learning in the course. Our findings suggest that the use of educational games in the classroom is likely to minimise distractions, thereby improving the quality of teaching and learning beyond what is provided in conventional classrooms. However, there is need for larger scale follow-up work to validate these effects.

Endnotes

[1]Medium-size lectures in New Zealand comprise over 40 students, with large lectures comprising more than 100.

Abbreviations

CALT: Committee for Teaching and Learning; GSRS: Game-based student response system; SRS: Student response system

Acknowledgements

We would like to thank the students for their participation in the interviews. We would also like to acknowledge Dr. Sander Zwanenburg and Dr. Grant Dick who designed and planned lessons around Kahoot! during the Information Systems Strategy and Governance course.

Funding

This work is funded by a University of Otago Teaching Development Grant—accessed through the Committee for Teaching and Learning (CALT).

Authors' contributions

The work performed in this manuscript is divided as follows. The study was initially designed by SAL, who also performed all interviews and managed all transcripts and demographic data. Transcripts were analysed by SAL and JLG, and reliability checks, data analysis and the recording of the results were also performed by these two authors. The method was documented by SAL, with support from the HEO. HEO, BD and SAL performed the literature review, evaluated the study outcomes and implications and limitations. Editorial reviews and formatting of the paper were done by the SAL, HEO and BD. All authors read and approved the final manuscript.

Authors' information

Sherlock A. Licorish is a lecturer in the Department of Information Science at University of Otago, in New Zealand. He was awarded his PhD by AUT, and his research centres on the use of games in Information Science education. Sherlock's research involves the use of data mining, data visualisation, statistical analysis and other quantitative methods (e.g. social network analysis, linguistic and sentiment analysis, natural language processing (NLP) and probabilistic modelling techniques). He has also used qualitative methods in his research, including qualitative forms of content analysis and dilemma analysis.

Helen Elizabeth Owen is a post-doctoral researcher at the University of Otago and an associate editor of *Social Behavior and Personality: An International Journal*. She obtained her PhD in Psychology in 2016 from the University of Otago. Her research encompasses areas of social cognition and forensic psychology, and more specifically focuses on social categorisation, language use and deception detection. She has also investigated the role of persuasive language in consumer decision-making. More recently, she has been researching in the field of human factors, exploring user

acceptance of technology and the users' experiences of expectation violation. She is involved in interdisciplinary projects with Information Science and the Higher Education Development Centre to explore the role of game-based student response systems in student learning and engagement at the University of Otago.
Ben Kei Daniel is an associate professor in Higher Education and the convener for Educational Technology for the University of Otago, New Zealand. His research broadly focuses on the examination of the value of Big Data and Learning Analytics in enhancing teaching, learning and research. He is also investigating Data Science approaches for educational research, as well as pedagogical theories and praxis for research methodologies in Business and Academia.
Jade Li George is an international consultant in London, UK. She advises and prepares international teachers and support staff for roles in the UK. Jade also previously provided student support and interventions for literacy, numeracy and phonics. Her research work focuses on qualitative data analysis, and exploring the use of game-based student response systems on classroom dynamics and students' learning.

Competing interests
The authors declare that they have no competing interests.

Publisher's Note

Author details
[1]Department of Information Science, University of Otago, PO Box 56, Dunedin 9054, New Zealand. [2]Department of Psychology, University of Otago, Dunedin, New Zealand. [3]Higher Education Development Centre, University of Otago, Dunedin, New Zealand.

Received: 13 January 2018 Accepted: 4 July 2018
Published online: 21 July 2018

References
Aleven, VA, & Koedinger, KR. (2002). An effective metacognitive strategy: learning by doing and explaining with a computer-based cognitive tutor. *Cognitive Science*, *26*(2), 147–179.
Baker, RS, D'Mello, SK, Rodrigo, MMT, Graesser, AC. (2010). Better to be frustrated than bored: the incidence, persistence, and impact of learners' cognitive–affective states during interactions with three different computer-based learning environments. *International Journal of Human-Computer Studies*, *68*(4), 223–241.
Barrio, CM, Muñoz-Organero, M, Soriano, JS. (2016). Can gamification improve the benefits of student response systems in learning? An experimental study. *IEEE Transactions on Emerging Topics in Computing*, *4*(3), 429–438.
Bradford-Networks (2013). *The impact of BYOD in education*. Cambridge, MA: Bradford Networks. Retrieved from http://www.bradfordnetworks.com/resources/whitepapers/the-impact-of-byod-in-education/.
Braun, V, & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101.
Cardwell, JE. (2007). Clickers in the large classroom: current research and best-practice tips. *CBE - Life Sciences Education*, *6*(1), 9–20.
Cheong, C, Cheong, F, & Filippou, J. (2013). Quick Quiz: A Gamified Approach for Enhancing Learning. In PACIS (p. 206). Jeju Island, Korea: AISeL.
Cope, D. (2014). Methods and meanings: credibility and trustworthiness of qualitative research. *Oncology Nursing Forum*, *41*(1), 89–91.
Csikszentmihalyi, M (1975). *Beyond boredom and anxiety*. San Francisco: Jossey-Bass.
Csikszentmihalyi, M (1991). *Flow: the psychology of optimal experience*. New York: Harper Perennial.
Daniel, BK. (2018). Empirical verification of the "TACT" framework for teaching rigour in qualitative research methodology. *Qualitative Research*. Advance online publication. https://doi.org/10.1108/QRJ-D-17-00012.
Dediu, I. (2015). *Tall Poppy Syndrome and its effect on work performance*. (Unpublished Doctoral dissertation). University of Canterbury, Christchurch, New Zealand. Retrieved June 5, 2018 from http://hdl.handle.net/10092/10261.
Deterding, S, Sicart, M, Nacke, L, O'Hara, K, & Dixon, D. (2011). Gamification. using game-design elements in non-gaming contexts. In *CHI'11 extended abstracts on human factors in computing systems*, (pp. 2425–2428). Vancouver, Canada: ACM.
Ebner, M, & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: an example from civil engineering. *Computers & Education*, *49*(3), 873–890.
Exeter, DJ, Ameratunga, S, Ratima, M, Morton, S, Dickson, M, Hsu, D, Jackson, R. (2010). Student engagement in very large classes: the teachers' perspective. *Studies in Higher Education*, *35*(7), 761–775.
Feather, NT. (1989). Attitudes towards the high achiever: the fall of the tall poppy. *Australian Journal of Psychology*, *41*(3), 239–267.
Finneran, CM, & Zhang, P. (2003). A person-artefact-task (PAT) model of flow antecedents in computer-mediated environments. *International Journal of Human-Computer Studies*, *59*(4), 475–496.
Gagné, R, & Driscoll, M (1988). *Essentials of learning for instruction*, (2nd ed.,). Englewood Cliffs: Prentice Hall.
Gagné, RM (1985). *The conditions of learning*, (4th ed.,). New York: Rinehart & Winston.
Gee, JP (2004). *Situated language and learning: a critique of traditional schooling*. London: Routledge Taylor & Francis.
Graham, K. (2015). TechMatters: getting into Kahoot!(s): exploring a game-based learning system to enhance student learning. *LOEX Quarterly*, *42*(3), 4.
Hay, DB. (2007). Using concept maps to measure deep, surface and non-learning outcomes. *Studies in Higher Education*, *32*(1), 39–57.
Holmes, JB, & Gee, ER. (2016). A framework for understanding game-based teaching and learning. *On the Horizon*, *24*(1), 1–16.

Huotari, K, & Hamari, J (2012). Defining gamification: a service marketing perspective. In *Proceedings of the 16th international academic MindTrek conference*, (pp. 17–22). Tampere, Finland: ACM.
Ismail, MA-A, & Mohammad, JA-M. (2017). Kahoot: a promising tool for formative assessment in medical education. *Education in Medicine Journal*, *9*(2), 19–26. https://doi.org/10.21315/eimj2017.9.2.2.
Jui-Mei, Y, Chun-Ming, H, Hwang, GJ, Yueh-Chiao, LIN. (2011). A game-based learning approach to improving students' learning achievements in a nutrition course. *TOJET: The Turkish Online Journal of Educational Technology*, *10*(2), 1–10.
Kay, RH, & LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: a review of the literature. *Computers & Education*, *53*(3), 819–827.
Ke, F (2009). A qualitative meta-analysis of computer games as learning tools. In RE Ferdig (Ed.), *Handbook of research on effective electronic gaming in education*, (pp. 1–32). New York: Hershey.
Kiili, K. (2005). Digital game-based learning: towards an experiential gaming model. *Internet and Higher Education*, *8*(1), 13–24.
Kolb, D, & Fry, R (1975). Towards an applied theory of experiential learning. In CL Cooper (Ed.), *Theories of group processes*, (pp. 103–136). London: Wiley.
Leaning, M. (2015). A study of the use of games and gamification to enhance student engagement, experience and achievement on a theory-based course of an undergraduate media degree. *Journal of Media Practice*, *16*(2), 155–170.
Licorish, SA, George, JL, Owen, HE, Daniel, B (2017). "Go Kahoot!" enriching classroom engagement, motivation and learning experience with games. In *Proceedings of the 25th International Conference on Computers in Education*, (ICCE 2017) (pp. 755–764). Christchurch, New Zealand: Asia-Pacific Society for Computers in Education.
Malone, TW (1980). What makes things fun to learn? Heuristics for designing instructional computer games. In *Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems*, (pp. 162–169). California, USA: ACM.
Marshall, MN. (1996). Sampling for qualitative research. *Family Practice*, *13*(6), 522–525.
Martin, AJ. (2008). Enhancing student motivation and engagement: the effects of a multidimensional intervention. *Contemporary Educational Psychology*, *33*(2), 239–269.
Marton, F, & Säljö, R. (1976). On qualitative differences in learning: I. Outcome and process. *British Journal of Educational Psychology*, *46*(1), 115–127.
McFarlane, A, Sparrowhawk, A, Heald, Y. (2002). *Report on the educational use of games. An exploration by TEEM of the contribution which games can make to the education process*. London: DfES.
Méndez, D, & Slisko, J. (2013). Software Socrative and smartphones as tools for implementation of basic processes of active physics learning in classroom: an initial feasibility study with prospective teachers. *European Journal of Physics Education*, *4*(2), 17–24.
Nacke, LE, Drachen, A, Göbel, S. (2010). Methods for evaluating gameplay experience in a serious gaming context. *International Journal of Computer Science in Sport*, *9*(2), 1–12.
Novak, JD (1998). *Learning, creating and using knowledge: concept maps as facilitative tools in schools and corporations*. Mahwah: Lawrence Erlbaum.
Papastergiou, M. (2009). Digital game-based learning in high school computer science education: impact on educational effectiveness and student motivation. *Computers & Education*, *52*(1), 1–12.
Patton, MQ (1990). *Qualitative evaluation and research methods*, (2nd ed.,). Newbury Park: Sage.
Pintrich, PR, & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom academic tasks. *Student Perceptions in the Classroom*, *7*, 149–183.
Plump, CM, & LaRosa, J. (2017). Using Kahoot! in the classroom to create engagement and active learning: a game-based technology solution for eLearning novices. *Management Teaching Review*, *2*(2), 151–158.
Poon, J. (2013). Blended learning: an institutional approach for enhancing students' learning experiences. *Journal of Online Learning And Teaching*, *9*(2), 271–289.
Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, *9*(5), 1–6.
Randel, J, Morris, B, Wetzel, C, Whitehill, B. (1992). The effectiveness of games for educational purposes: a review of recent research. *Simulation and Gaming*, *23*(3), 261–276.
Roehl, A, Reddy, SL, Shannon, GJ. (2013). The flipped classroom: an opportunity to engage millennial students through active learning. *Journal of Family and Consumer Sciences*, *105*(2), 44.
Rosas, R, Nussbaum, M, Cumsille, P, Marianov, V, Correa, M, Flores, P, et al. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. *Computers and Education*, *40*(1), 71–94.
Sellar, M. (2011). Poll everywhere. *The Charleston Advisor*, *12*(3), 57–60.
Siegle, D. (2015). Technology: learning can be fun and games. *Gifted Child Today*, *38*(3), 192–197.
Squire, K. (2005). Changing the game: what happens when video games enter the classroom? *Innovate*, *1*(6). Retrieved April 8, 2017 from https://www.learntechlib.org/p/107270/.
Squire, K. (2011). Video games and learning: teaching and participatory culture in the digital age. Technology, Education--Connections (the TEC Series) Teachers College Press. New York.
Tapper, CL. (2014). *Being in the world of school; Phenomenological exploration of experiences for gifted and talented adolescents*. (Unpublished Doctoral dissertation). University of Canterbury, Christchurch, New Zealand. Retrived June 5, 2018 from http://hdl.handle.net/10092/9057.
Wang, AI. (2015). The wear out effect of a game-based student response system. *Computers & Education*, *82*, 217–227.
Wang, AI, & Lieberoth, A (2016). The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot!. In *Proceedings from the 10th European Conference on Games Based Learning*, (p. 738). Reading, UK: Academic Conferences International Limited.
Wang, YS, Wu, MC, Wang, HY. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational Technology*, *40*(1), 92–118.
White, M, & Dorman, SM. (2001). Receiving social support online: implications for health education. *Health Education Research*, *16*(6), 693–707.
Yen, J-C, & Lee, C-Y. (2011). Exploring problem solving patterns and their impact on learning achievement in a blended learning environment. *Computers & Education*, *56*(1), 138–145.
Yin, RK (2013). *Case study research: design and methods*. London: Sage publications.